in orderly form and discussing as it does a vast amount of material of observation, is the pointing out of gaps in available data. The pages of these "studies" raise numerous questions which must be settled in order that the whole fabric of luminescence theory may be further extended. Undoubtedly many of the questions so raised will be worked out in the same laboratories from which the present researches have been issued.

Even thus far the work represented in the present memoir constitutes a most noteworthy series of researches in the general field of luminescence. Not only the care and patience with which the observations have been made, but much more the experimental acumen with which the methods and materials have been chosen and the illuminating discussions of theoretical character, all contribute to give these researches a place beside those of the middle of the past century by which E. Becquerel blazed the way into this wonderfully interesting region. Recent developments in physics attach much more of importance to the phenomena of luminescence than could possibly have been foreseen in those earlier years, and it seems certain that further developments, in this and allied branches of physics, will greatly enhance the value of the region as a field for research.

F. E. Kester

SPECIAL ARTICLES

NON-ELECTROLYTES AND THE COLLOID-CHEMICAL THEORY OF WATER ABSORPTION

The colloid-chemical theory best explains at the present time the absorption of water by protoplasm under various physiological and pathological conditions. The laws governing the absorption of water by such simple protein colloids as fibrin and gelatine, are point for point identical with those which we have known to govern the absorption of water by cells, tissues, organs, or the organism as a whole. Thus fibrin and gelatine swell more in any acid solution than in distilled water, while protoplasm does the same. The addition of any salt to the acid solution reduces the amount of this swelling, and this the more the higher the concentration of the salt. The same holds for protoplasm. At the same concentration different salts arrange themselves in a characteristic order in this regard. The same order is observed in protoplasm.

In this way it has been possible to explain without contradiction not only all those phenomena which are ordinarily said to prove the tenability of the laws of osmotic pressure for the processes of absorption and secretion, as observed in protoplasm under various pathological and physiological circumstances, but also the notable exceptions in behavior, which no one believes explainable on the osmotic basis.

In the study of fibrin and gelatine, it was found that various non-electrolytes, such as sugars and alcohols, are *relatively* ineffective in reducing their swelling in the presence of any acid. Adherents to the osmotic theory of water absorption have made this statement read, *entirely* ineffective; and, because certain non-electrolytes bring about shrinking effects in various cells and tissues, have seen in this a valid reason for rejecting the dominant importance of the colloids and their state in determining the amount of water held by protoplasm.

During the past year a systematic study of the effect of various non-electrolytes on the swelling of gelatine and fibrin has been undertaken. *The effect of non-electrolytes upon these is identical with their effect upon protoplasm.* The various organic compounds thus far studied (saccharose, dextrose, levulose glycerine, ethyl alcohol, methyl alcohol, propyl alcohol, propylene glycol, etc.) all decrease the swelling of gelatine or fibrin in either neutral or acid solution, and this the more the higher the concentration of the added compound. When equally concentrated (equimolecular) solutions are compared the sugars are found to be more effective than the alcohols in this regard. The same is true of protoplasm. The sugars among themselves are unequally effective in dehydrating protein colloids, and in a similar way are they unequally effective in dehydrating living tissues.

We have defined the excess of water held by tissues under various abnormal circumstances and known under the varying names of excessive turgor, plasmoptysis, edema, etc., as a state of excessive hydration of the tissue colloids, more particularly of the proteins. As the causes of this we have assigned any substance or condition which, under the circumstances surrounding the living cell, is capable of increasing the hydration capacity of its colloids. As the most potent of these causes we have regarded, and still regard, an abnormal production or accumulation of acid in the involved cell. Of other substances conceivably active in certain tissues, which thus increase the hydration capacity of the tissue colloids, we have studied urea. The addition of urea increases in all concentrations the swelling of gelatine and fibrin, and this the more the higher the concentration of the urea. In the higher concentrations of urea both gelatine and fibrin are hydrated so heavily that they go into solution. The urea hydration is not a simple alkali effect, for acid in no concentration counteracts it. The hydrating effects of acid and of urea are additive. There is, however, an interesting difference between the increased hydration brought about by acids and that induced by urea. While salts reduce the former, they do not affect the increased hydration induced through urea. On the other hand, various non-electrolytes which affect the hydration brought about by acids but little, reduce that produced by urea almost entirely.

These facts, taken in conjunction with our previous studies on the colloid-chemistry of absorption and secretion, help toward an interpretation of certain well-known biological and medical facts. They explain on a colloid-chemical basis the behavior of the sugars and certain other organic substances in reducing the absorption of water by tissues. They explain the cathartic action of glycerine, the sugars, etc. They also explain the diuretic action of these substances, accounting for the polyuria of diabetes, the relative dryness of the diabetic's tissues and his thirst. We get an insight into the mechanism of urea hemolysis. Also we learn another method of dehydrating edematous tissues, which owe their excessive hydration to other circumstances than the presence of acid or the absence of salts. In addition to using sugar in order to correct the "acidosis" of certain pathological states from a biochemical point of view, we have made practical use of the above facts by using sugar along with the alkali and hypertonic salt mixtures previously recommended in combating the edemas of the eye (glaucoma), brain (uremia), medulla (pernicious vomiting), kidney (nephritis), and other organs observed in various clinical conditions. The use of dextrose along with salts and alkali in these conditions has yielded even better results than have previously been reported.

A series of papers submitted for publication in the *Kolloid Zeitschrift* will shortly bring the details of these various findings.

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CHANGES DURING QUIESCENT STAGES IN THE METAMORPHOSIS OF TERMITES

THERE have been several theories as to when the larvæ of termites become differentiated to the various castes in the social organization, the prevalent theory being that undifferentiated larvæ are developed to the castes by the character of the food that they receive. The results of Heath's[1] experiments, however, to determine the relation of various kinds of food to polymorphism were negative. In case of the ants, Wheeler[2] with Emery believes "the adult characters to be represented in the germ as dynamical potencies or tensions rather than morphological or chemical determinants" and that "nourishment, temperature and other environmental factors merely furnish the condi-

[1] Heath, H., "The Habits of California Termites," *Biol. Bull.*, Woods Hole, Vol. IV., December, 1902, pp. 47–63.

[2] Wheeler, W. M., "The Polymorphism of Ants," *Bull. Amer. Mus. Nat. Hist.*, Vol. XXIII., January, 1907, pp. 1–93.